Time and the laws of Nature

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Abstract

What is time? Why does it "flow" and why are we sure that it flows from past towards future? Why is there such a gigantic distinction between the Past of our world, which we believe to be fixed, and the Future, which we consider undetermined? And this is in spite of the fact that almost all physical laws are time-symmetric! Why does previously undetermined "Future" acquire its steadiness as it passes the moment called "the Present"? Perhaps, these questions are partially answered in the considerations below.

Let us retract from our particular Universe and think about what kind of laws can in principle govern the development of universes. As a universe, we will understand any world, even an imaginary one, that can have different states and has laws of transition from one state to another as "time" passes by. Generally speaking, such laws can be probabilistic, i.e. they set the probabilities of transition from one particular state to another.

Let us group these laws in categories on the basis of their respect to time.

The first, and the most widespread in our world, category is the category of bilaterally deterministic laws. "Bilaterally" means that these laws determine unambiguously what was the precursor and what will be the successor to a given state. (For the sake of simplicity, we will assume time discrete.)

The second possible type of law embraces bilaterally undeterministic (probabilistic) laws. In other words, starting from a given present state, we can arrive, with a certain probability, to a number of different states. The present state, in its turn, can be the result of evolution of several possible states in past, again with certain probabilities. (The case of complete chaos falls precisely into this category.)

Laws of the third type, which we intend to discuss in detail, are unilaterally deterministic laws. This means that such a law will uniquely prescribe what a given state will evolve into. However, the present state itself can originate from different states in past.

At the first glance, one could think of laws of the fourth category, i.e. laws that fix the ancestor to a given state but is probabilistic in respect to its successors. However, since the direction of time axis is subjective, this category is identical to the third one, which will be discussed later in more detail.

An example of the universe evolving in compliance with the third type of laws is given by the famous Conway's Game of Life. Let me briefly describe it. A 2D square grid is

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populated by a colony of tips, each tip living in one cell. If a tip has two or three neighbors, it survives and proceeds to the next generation. Tips with zero or one neighbor die of "loneliness", while those with more than three neighbors die of "overcrowding". New tips are born in cells contiguous to exactly three living tips. The laws of evolution in this world are more than simple, with every next generation being unambiguously determined by the previous one; the development of colonies can turn out very interesting.

However, it is plain to see that it is far from an easy task to restore the previous state of a given one. Moreover, there can be a multitude of them. Now think of a researcher who watches how these states turn into one another but he watches this backward in time. He is trying to determine the laws this evolution follows but at best he can deduce only probabilistic distributions to obtain this or that state from a given one.

What does it look similar to?

Now I proceed to my principal statement: **the laws of our world are of unilaterally deterministic nature, if we choose "from future to past" as the correct direction of the time axis.**

Apparently, the combination of unilaterally and bilaterally deterministic laws results in the unilaterally deterministic world, therefore the majority of the known laws does not determine the general nature of our universe. Moreover, the majority of laws are known to be CP-even and thus can be classified as laws of the first or second category. (As a matter of fact, I am deeply convinced that there are no laws of the second kind in our universe. Otherwise, if there were several alternatives to past, how could we remember the only one of them, known as "the Past"?) The only exclusion I am aware of (I apologize for my possible ignorance) is the weak interaction. Evidently, it is the weak interaction that possesses the unilaterally deterministic nature and, in absence of the competitors, determines the unilateral nature of our universe. This explains the enormous difference between the past and the future, which is clearly apparent to any of us. We do remember our past, because it is uniquely determined by the present. We know that millions of years ago the Earth was inhabited by dinosaurs but no one has even a slightest idea who will occupy the Earth million years from now. We can "remember" and accumulate information because the past is strictly determined. Almost entire (see below more on "almost") information about the past is contained in the present. But not the information on the future. If the laws of nature were bilaterally deterministic, there would be no chance of any slightest development (in our understanding of this word). Time would be simply another dimension of the space, though quite a peculiar one.

Now - several speculative remarks on why our Universe is what it is and what conclusions can be drawn from the above discussion.

1. Of course, one might seem quite naive to tackle this "why" question, but nonetheless I suggest doing this on the basis of assumption that the world is designed in such a way that it ensures the existence of OBSERVERS. In other worlds, even if they exist, there is nobody to ask this question. So, starting from universal CPT conservation, one can conclude that in the world built of antimatter time will flow in the opposite direction. I.e. in this world the future is fixed, while the past can have alternatives. So, the well known problem "how to determine by means of radiowave communication whether you are talking to a creature built of matter or antimatter" no longer arises. Indeed, such a contact is just impossible, since the same signal will be considered emitted by both parties (by an antenna - at the one end, by synchronously distinct atoms towards the antenna - at the other). The information exchange is simply impossible.

But nevermind, there seem to be no problems with antimatter creatures in our world by the virtue of almost absolute absence of the antimatter itself. But since the antimatter has "time-opposite" nature, it introduces indeterminacy into our past. Obviously, it is matter-to-antimatter relation that dictates the relation between indeterminacy in past and future. These two forms of disproportion - between matter and antimatter content of our universe, and between determinacy in past and future - are not only connected, but also necessitate one another.

2. One should undertake a search for some relatively simple laws that the weak interaction follows in the "backward time".

3. If there exist only finite number of states of universe, there must also exist special states, called "Gardens of Eden", that have (in the backward time) successors but do not have any precursor (if some states have more than one precursors, then there are no precursors left for some of the other). For the usual direction of the time axis it means that there is NO SINGLE state that our present state can evolve into. That is, "Garden of Eden" for us is the apocalypse in its direct and literal meaning. In the Game of Life such "Gardens of Eden" have been found. This problem is however removed in the case of infinite number of states. (An example: a universe, whose states are real numbers from 0 to 1. The evolution law: take the infinite decimal fraction that represents this number and erase the first decimal digit. The resulting number represents the next state of the universe. It is clear that every state of this universe has ten precursors.)

4. The model of unilaterally deterministic universe removes the contradiction between "God does not play dice" and the freedom of will, obviously given to a human being. If one wishes, one can think that God has created a finite (finite for us) state of the universe and the laws of universe evolution in the "backward time". And now He is surprised to find people who think that everything is evolving in the opposite time.

5. The choice of time axis direction is subjective.

If we introduce another axis, arrange all states of the universe along it, and undertake an unbiased analysis, we will find the following. At each moment of time t creatures dwelling in the Universe are convinced that the moment of time $t-1$ was in past. What is the ground for this belief? Only the fact that creatures possess significantly richer information about this moment than about moment $t+1$. And at the moment $t+1$ they "remember" that "some time ago", at moment t, they have just learn about this moment t. This tempts them to think that time is directed from past to future. But I think that as far as the physical laws are concerned, the correct choice of time axis direction should be exactly opposite.